



# Time Domain Stability Margin Assessment Method

Keith Clements

MSFC / EV41 / Jacobs ESSSA Group

---

Breckenridge, Colorado

Rocky Mountain Section



AAS Publications Office, P.O. Box 28130 - San Diego, California 92198

## **ABSTRACT**

The baseline stability margins for NASA's Space Launch System (SLS) launch vehicle were generated via the classical approach of linearizing the system equations of motion and determining the gain and phase margins from the resulting frequency domain model. To improve the fidelity of the classical methods, the linear frequency domain approach can be extended by replacing static, memoryless nonlinearities with describing functions. This technique, however, does not address the time varying nature of the dynamics of a launch vehicle in flight. An alternative technique for the evaluation of the stability of the nonlinear launch vehicle dynamics along its trajectory is to incrementally adjust the gain and/or time delay in the time domain simulation until the system exhibits unstable behavior. This technique has the added benefit of providing a direct comparison between the time domain and frequency domain tools in support of simulation validation.